

## **Taxonomic Review of the Family Lumbricidae (Oligochaeta) in Korea**

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### **ABSTRACT**

Seven species of the Korean Lumbricidae, including a newly recorded species, *Aporrectodea tuberculata*, are reviewed, with illustrations, descriptions and key of the known species in Korea. Other 3 species of the previously known species of the family were not found in this study.

Key words: taxonomy, Oligochaeta, Lumbricidae, Korea

### **INTRODUCTION**

The earthworm fauna of the agricultural and garden soils in Korea is dominated by the introduced species of Lumbricidae from Europe. These introduced species are often transported by workers during agricultural activities. The early reports of Lumbricidae from Korea were made by Kobayashi (1935, 1936, 1938, 1941), and Song and Paik (1969, 1970a, b). The Korean Lumbricidae comprise nine species belonging to four genera; *Aporrectodea* Orley, *Bimastos* Moore, *Eisenia* Malm, and *Dendrobaena* Eisen. However, these of them; *Aporrectodea caliginosa*, *Eisenia japonica*, and *E. nordenskjoldi* were not found during this study. *Aporrectodea tuberculata* is reported for the first time from Korea. This paper provides descriptions of the 9 species and a key for identifying them. Materials were collected from 1996 to 1998, in farmland and litter layers and soils of forests, in the Gyung-sangbuk-do region of Song's samples from 1965 to 1971.

All species, except *B. parva*, *B. beddardi* are European. *B. parva* has been wide spreaded in numerous locations outside North America. These European species found in this study are now cosmopolitan in temperate climates, due to accidental and intentional transport by humans.

## SYSTEMATIC ACCOUNTS

Genus *Aporrectodea*, Orley 1885 낚시지렁이속 (신칭)

***Aporrectodea trapezoides* (Duges, 1828) 갈색낚시지렁이 (Fig. 1)**

*Lumbricus trapezoides* Duges, 1828, p. 289.

*Allolobophora caliginosa trapezoides*: Chen, 1931, p. 168; Kobayashi, 1935, p. 130, 1938, p. 6; 1941, p. 150; Song and Paik, 1969, p. 13; Song and Paik, 1970a, p. 10; Song and Paik, 1970b, p. 107.

*Allolobophora caliginosa*: Eaton, 1942, p. 246.

*Allolobophora trapezoides*: Gates, 1972a, p. 76.

*Aporrectodea trapezoides*: Reynolds, 1975, p. 3; 1977, p. 46.

**Material examined.** 6 clitellate, Gige-myon, Yongil-gun, Gyung-sangbuk-do, 17 July 1966, S.Y. Lee; 1 clitellate, Gaksan, Chilgok-gun, Gyung-sangbuk-do, 12 August, 1971, E.D. Yeo; 5 clitellate, 3 acitellate, Gyung-san, Gyung-san-gun, Gyung-sangbuk-do, 17 July 1971, J.H. Kim; 7 clitellate, Yangsan-ri, Dongjin-myon, Buan-gun, Jeollabuk-do, 03 April 1996. 10 clitellate, Samrye-ri, Samrye-eup, Wanju-gun, Jeollabuk-do, 16 March 1996; 5 clitellate, 1 acitellate, Mt. Sonun, Gochang-gun, Jeollabuk-do, 06 July 1996; 4 clitellate, 19 acitellate, Mt. Sonun, Gochang-gun, Jeollabuk-do, 03 October 1996; 1 clitellate, 7 acitellate, Gumun Isl. Wando-gun, Jeollanam-do, 07 September, 1996.

**Description.** Length 61-87 mm, diameter 3.5-4.0 mm at segment x, 3.7-4.5 mm at clitellum (xxx); body dorso-ventrally flattened, rectangular in cross-section, segments 120-146. Setae closely paired, 8 per segment around equators, size regular; setal formula  $AA > AB$ ,  $AB < CD$ ,  $DD > AA$ . Prostomium epilobous. Light brownish, slate dorsally, yellowish ventrally. Clitellum saddle shape (xxvi), xxvii-xxxiv; thick,  $CD$  setae and dorsal pores invisible externally within clitellum.

Male pores ventral in xv, between  $B$  and  $C$ , on protuberance occupying xiv-xvi. Tubercula pubertatis longitudinal bands between  $B$  and  $C$ , xxxi-xxxiii, (xxxiv). Genital tumescences ix-xi, xxx-xxxiii, often xxviii, surrounding  $AB$ . Spermathecal pores in 9/10 and 10/11, small pores just above  $C$ . Female pore lateral to  $B$  in xiv, first dorsal pore 8/9 or 9/10. Nephropores unrecognizable.

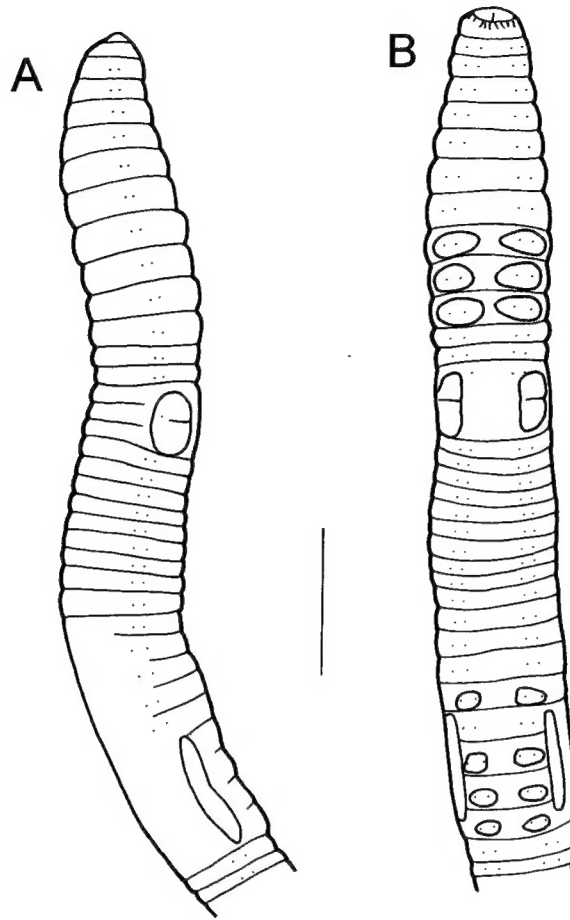
Septa 5/6-12/13 muscular, 13/14, 14/15 thinner. Intestine begins in xv, lymph glands absent. Typhlosole small and thick in xxi. Hearts in vii-xii. Nephridial bladders about  $CD$  line. Male sexual system holandric. Seminal vesicles four pairs in ix-xii, ix and x very small, sometimes traces, paired small spermathecae x and xi.

**Remarks.** It is an important decomposer in farmhouse compost heaps, where it reaches very high densities in the spring breeding season. *Allolobophora caliginosa trapezoides* as reported previously from Korea.

***Aporrectodea tuberculata* (Eisen, 1874) 흑낚시지렁이 (신칭) (Fig. 2)**

*Allolobophora turgida* f. *tuberculata* Eisen, 1874, p. 43.

*Allolobophora caliginosa*: Eaton, 1942, p. 246.



**Fig. 1.** *Aporrectodea trapezoides*: A, dorsolateral view; B, ventrolateral view. Scale lines 5.0 mm.

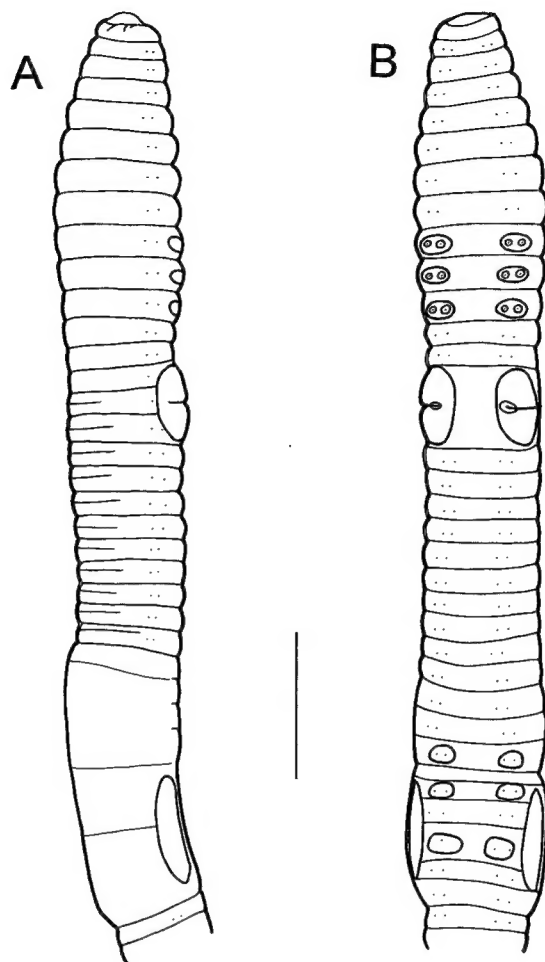
*Allolobophora tuberculata*: Gates, 1972b, p. 44.

*Aporrectodea tuberculata*: Reynolds, 1975, p. 3; Reynolds, 1977, p. 50.

**Material examined.** 13 clitellate, Baejamo, 20 May 1968, M.J. Song.

**Description.** Length 82–117 mm, diameter 3.8–4.5 mm at segment x, 4.0–5.3 mm at clitellum (xxx); body dorso-ventrally flattened slightly, cylindrical in cross-section, segments 83–142. Setae closely paired, 8 per segmental around equators, size regular; setal formula  $AA > AB$   $AB < CD$ ,  $AB = CD$ ,  $DD > AA$ . Prostomium epilobous. Light brownish or slate dorsally, yellowish ventrally. Clitellum saddle shape (xxvi), xxvii–xxxiv; thick, CD setae and dorsal pores invisible externally within clitellum.

Male pores ventral in xv, between AB and AB, on protuberance occupying xiv–xvi. Tubercula pubertatis longitudinal bands between B and C, xxxi–xxxiii. Genital tumescences, ix–xi, xxiv, xxx, xxxii, rarely xxxiv, surrounding AB. Spermathecal pores in 9/10 and 10/11, just above C, inconspicuous. Female pore lateral to B in xiv. First dorsal pore 10/11, variable. Nephropores unrecognizable.



**Fig. 2.** *Aporrectodea tuberculata*: A, dorsolateral view; B, ventrolateral view. Scale lines 5.0 mm.

Septa 5/6-12/13 muscular, 13/14, 14/15 thin. Intestine begins in xv, lymph glands from xviii, two pairs per segment. Typhlosome small from xxiii. Hearts in vii-x. Nephridial bladders about CD line, large, sheet-shape. Male sexual system holandric. Seminal vesicles four pairs in ix-xii. Paired small spermathecae x and xi.

**Remarks.** The species live in soils, turf, bogs, compost, but rarely manure (Gates, 1972). This species is obligatory amphimictic with copulation beneath the soil surface (Reynolds, 1974). The species was identified from Song's material, but the collecting locality is not known precisely. This is a new record for Korean fauna. *A. tuberculata* lacks the pair of genital tumescence on segment xxxiii, which separates it from *A. trapezoides*.

Genus *Bimastos* Moore, 1893 뽕뉡시지렁이속 (신칭)

***Bimastos beddardi* (Michaelsen, 1894) 넓은뽕뉡시지렁이 (Fig. 3)**

*Allolobophora beddardi* Michaelsen, 1894, p. 182.

*Allolobophora (Bimastus) beddardi*: Michaelsen, 1900, p. 13.

*Helodrilus beddardi*: Smith and Green, 1916, p. 83.

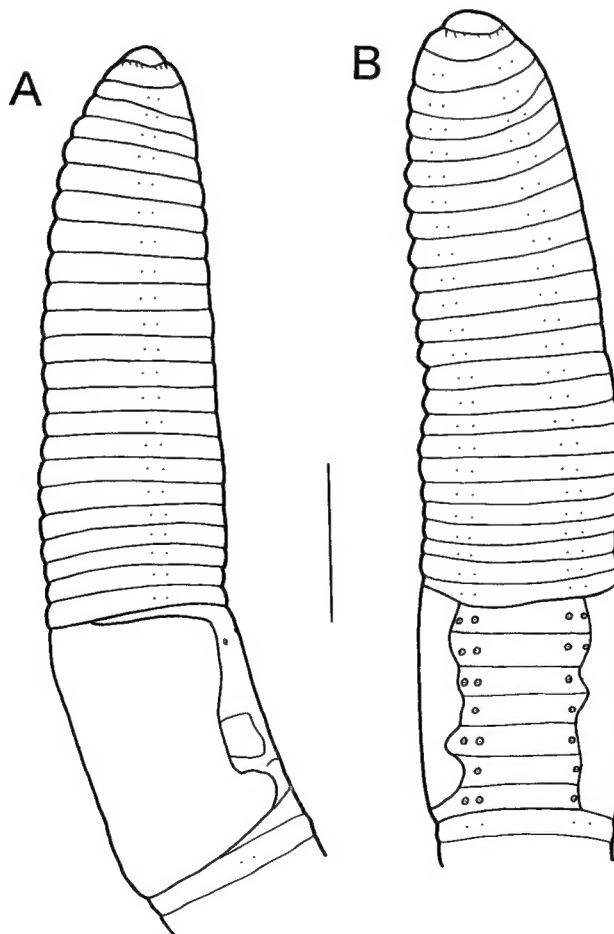
*Bimastus beddardi*: Kobayashi, 1941, p. 16.

**Material examined.** 7 clitellate, Mt. Keryong, Daejeon-shi, 9 July 1996.

**Description.** Length 26–56 mm, diameter 1.5–2.1 mm at segment x, 2.1–2.5 mm at clitellum (xxx); body cylindrical in cross-section, segments 103–111. Setae closely paired, 8 per segment around equators, size regular; setal formula  $AA > AB$   $AA > BC$   $DD > AA$ ,  $AB = CD$ . Prostomium epilobous. Pink or red color formalin preservation. Clitellum saddle shape xxiv–xxxi.

Male pores ventral in xv, inconspicuous. Tubercula pubertatis absent. Genital tumescences lacking, if present xxv–xxvi, xxviii, xxx. Female pore lateral to *B* in xiv. First dorsal pore 4/5. Nephropores unrecognizable.

Septa 5/6, 6/7 thick, 7/8–13/14 thinner. Intestine begins in xv, lymph glands absent. Typhlosole small from xxiii. Hearts in ix–xi. Nephridial bladders about *CD* line. Male sexual system holandric. Seminal vesicles xi–xii.



**Fig. 3.** *Bimastus beddardi*: A, dorsolateral view; B, ventrolateral view. Scale lines 2.0 mm.

***Bimastos parva* (Eisen, 1874) 안장띠늬시지렁이 (Fig. 4)**

*Allolobophora parva* Eisen, 1874, p. 46.

*Bimastos parvus*: Kobayashi, 1938.

*Bimastos parvus*: Gates, 1972a, p. 87; Reynolds, 1977, p. 61.

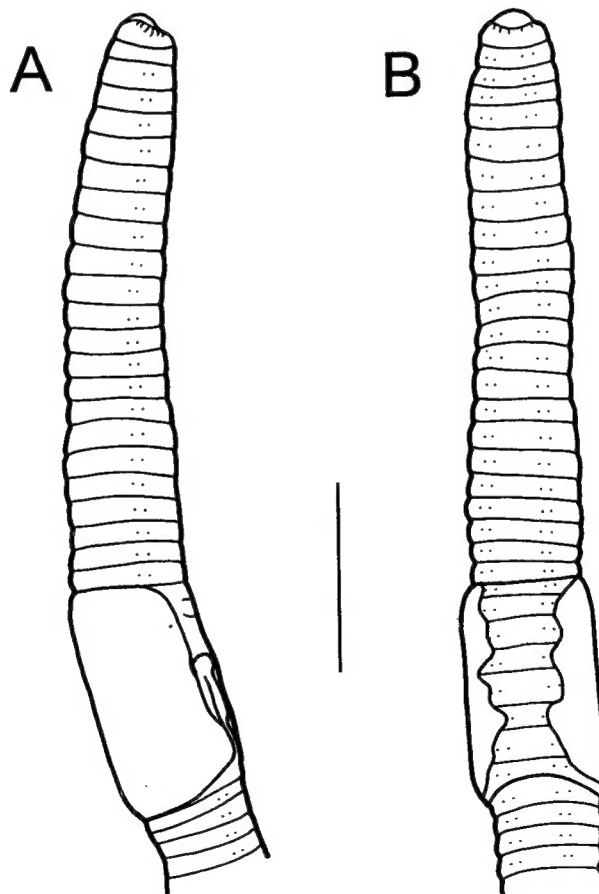
**Material examined.** 7 clitellate, Mt. Naejang, Jeongeup-shi, Jeollabuk-do, 29 June 1996.

**Description.** Length 37-53 mm, diameter 1.4-1.7 mm at segment x, 1.8-2.4 mm at clitellum (xxx); body cylindrical in cross-section, segments 101-109. Setae closely paired, 8 per segment around equators, size regular; setal formula  $AA > AB$   $AA > BC$   $DD > AA$ ,  $AB = CD$ . Prostomium epilobous. Unpigmented formalin preservation. Clitellum saddle shape xxiv, xxv-xxx.

Male pores ventral in xv, between B and C. Tubercula pubertatis absent. Genital tumescences lacking. Female pore lateral to B in xiv. First dorsal pore 4/5 or 5/6. Nephropores unrecognizable.

Septa 5/6, 6/7 thick, 7/8-13/14 thin. Gizzard large in xvii. Intestine begins in xv, lymph glands absent. Typhlosome small from xxii. Hearts in viii-x. Male sexual system holandric. Seminal vesicles xi-xii, xii large.

**Remarks.** This is a small worm, like *B. beddardi*, and it is difficult to separate from the later by



**Fig. 4.** *Bimastos parva*: A, dorsolateral view; B, ventrolateral view. Scale lines 3.0 mm.

external characters. *B. parva* has the clitellum on segment xxiv, xxv-xxx, distinct from the xxiv, xxv-xxxi of *B. beddardi*. Gates (1972) reported it from soils, human habitations, gardens, fields, humus, and manure.

Genus *Eisenia* Malm, 1877 줄지렁이속 (신칭)

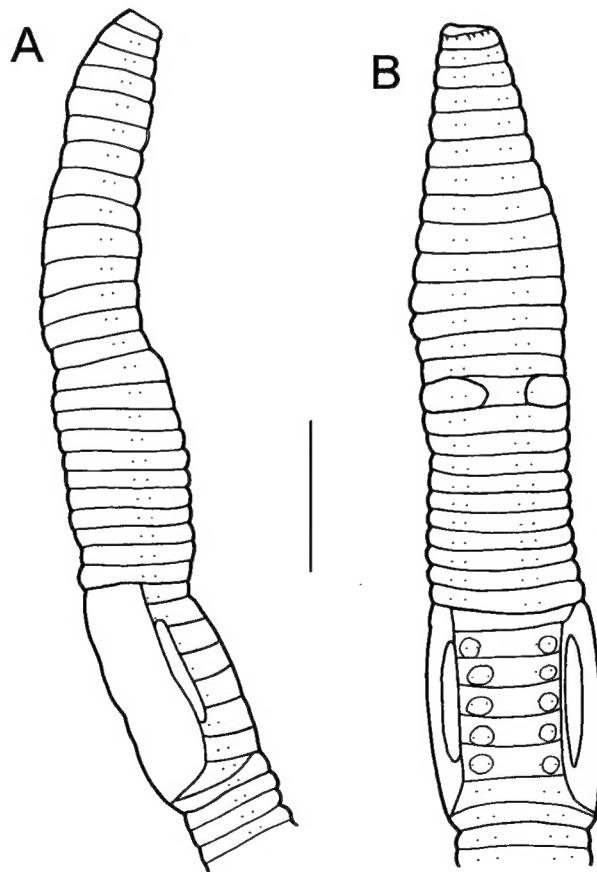
***Eisenia fetida* (Savigny, 1826) 줄지렁이 (Fig. 5)**

*Enterion fetidum* Savigny, 1826, p. 182.

*Allolobophora foetida*: Beddard, 1895, p. 702.

*Eisenia foetida*: Michaelsen, 1900, p. 475; Kobayashi, 1938, p. 6; Kobayashi, 1941, p. 148; Song and Paik, 1969, p. 14; Gates, 1972a, p. 97; Reynolds, 1977, p. 74.

**Material examined.** 1 clitellate, 5 a clitellate, Daegu-shi (Gisan elementary school), 25 July 1967, M.J. Song; 14 clitellate, 23 a clitellate, Gampo-eup, Gyungju-gun, Gyungsangbuk-do, 12-16 July 1968, M.J. Song; 2 clitellate, Gyungsan, Gyungsan-gun, Gyungsangbuk-do, 17 July 1971, J.H. Kim; 1 clitellate, Gaksan, Chilgok-gun, Gyungsangbuk-do, 12 August, 1971, E.D. Yeo ; 17 clitellate, 2 a clitellate, Dabudong, Chilgok-gun, Gyungsangbuk-do, 12 August, 1971, E.S. Lee; 44 clitellate, 3 a clitellate, Mt. Kumho, Gumi-shi, Gyungsangbuk-do, 13 August 1971, E.D. Yeo; 11



**Fig. 5.** *Eisenia fetida*: A, dorsolateral view; B, ventrolateral view. Scale lines 5.0 mm.

clitellate, 5 acitellate, Chochen-myon, Bukjeju-gun, Jeju-do, 23 August, 1970, I.C. Lim; 4 clitellate, 3 acitellate, Samrye-ri, Samrye-eup, Wanju-gun, Jeollabuk-do, 16 March 1996; 1 clitellate, Jeonju-shi, Jeollabuk-do, 1 April, 1996; 21 clitellate, 6 acitellate, Yangsan-ri, Dongin-myon, Buan-gun, Jeollabuk-do, 3 April 1996; Compost heaps, Pyeongtaek, Gyonggido, 10 April 1998; Compost heaps (46 clitellate and 3 acitellate specimens) Yeongi, Chungchongnam-do, 10 April 1998.

**Description.** Length 52-92 mm, diameter 3.0-4.1 mm at segment x, 2.8-3.6 mm at xx, 3.5-4.8 mm at clitellum (xxviii); body cylindrical in cross-section, segments 82-103. Setae closely paired, 8 per segment around equators, size regular; setal formula  $DD > CD < AA > AB$ ,  $CD = AB$ . Prostomium epilobous, 1/2 with tongue open. Red brownish dorsally, with red-brown transverse pigmented bands on dorsal, alternating with yellowish intersegmental furrows; yellowish ventrally, clitellum yellowish, formalin preservation. Clitellum saddle shape xxvi-xxxii, thick,  $CD$  setae and dorsal pores invisible externally within clitellum.

Male pores near lateral margins of ventral in xv; on protuberance area, pore area slightly depressed between  $B$  and  $C$  setae line, with pores centered. Tubercula pubertatis, longitudinal bands, just lateral to  $B$  (xxvii, xxix), xxviii-xxx, (xxxi). Genital tumescences, xxiv, xxv, xxvi, xxvii, xxviii-xxxi, xxxii, just to  $B$ , oval shape, sometimes faintness. Spermathecal pores in 9/10 and 10/11, small pores near the dorsal pore lines. Female pore in xiv. First dorsal pore 4/5. Nephropores unrecognizable.

Septa usually thin. Lymph glands absent, typhlosole large and thick in xx. Hearts in vii-xi. Nephridial bladders with digitiform. Male sexual system holandric, testes and funnels in ventral paired sacs in x, xi. Seminal vesicles three pairs in ix-xii, sometimes ix, x, xi-xii, Paired spermathecae in ix, x; each ampulla middle voluminous pouch, thick, ducts short.

**Remarks.** This species is a common earthworm in agricultural ecosystems, and is widely used in vermiculture and composting. They live in decaying fallen leaves, compost heaps, manure piles, and other accumulations of organic matter as well as *A. trapezoides*.

### **Eisenia rosea (Savigny, 1826) 장미줄지렁이 (Fig. 6)**

*Enterion roseum* Savigny, 1826, p. 182.

*Lumbricus roseus*: Duges, 1837, p. 17.

*Eisenia rosea*: Michaelsen, 1900, p. 478.

*Helodrilus (Bimastus) bimastoides*: Michaelsen, 1903, p. 13.

*Allolobophora rosea*: Edwards and Lofty, 1972, p. 217.

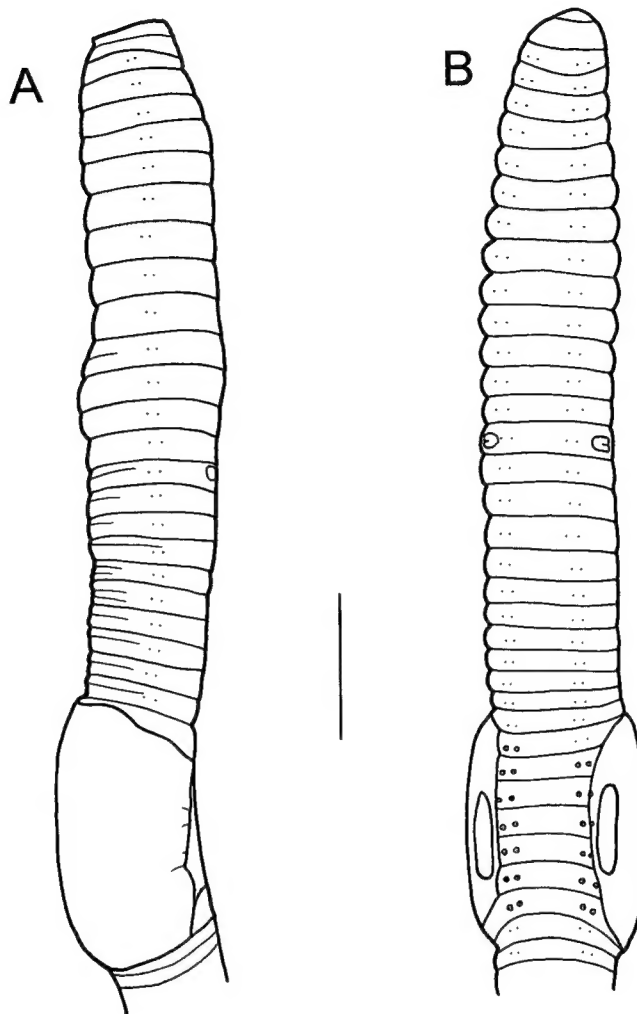
*Aporrectodea rosea*: Gates, 1976, p. 4.

*Eisenia rosea*: Kobayashi, 1936, p. 183; Reynolds, 1977, p. 78.

**Material examined.** 11 clitellate, 94 acitellate, Sinci-do, Jeollabuk-do, 31 July 1996; 2 clitellate specimens, Bamsagol, Mt. Jiri, Jeollabuk-do, 18 June 1996.

**Description.** Length 55-82 mm, diameter 2.6-2.9 mm at segment x, 2.7-3.0 mm at clitellum (xxx); body cylindrical in cross-section, segments 119-138. Setae closely paired, 8 per segment around equators, size regular; setal formula  $AA > AB > CD$ ,  $AA > BC < DD$ . Prostomium epilobous. Unpigmented formalin preservation. Clitellum saddle shape (xxv), xxvi-xxxii (xxxiii),  $CD$  setae and dorsal pores invisible externally within clitellum.





**Fig. 6.** *Eisenia rosea*: A, dorsolateral view; B, ventrolateral view. Scale line 3.0 mm.

Male pores ventral in xv, between B and C, on slight protuberance. Tubercula pubertatis longitudinal bands, xxix-xxxi, between B and C. Genital tumescences absent. Spermathecal pores in 9/10 and 10/11, unrecognizable. Female pore lateral B in xiv. First dorsal pore 4/5. Nephropores inconspicuous.

Septa 5/6-8/9 thick muscular, 9/10 less so, 10/11-12/13 thin. Intestine begins in xv, lymph glands absent. Typhlosome low, simple from xxi. Hearts usual in vii-x. Nephridial bladders large about CD line. Male sexual system holandric. Seminal vesicles ix-xii, ix and x very small, sometimes traces, paired small spermathecae x and xi.

**Remarks.** The species is found in a variety of habitats, including fields, gardens, pastures, and forests under leaves and stones. *E. rosea* is one of the cosmopolitan species which was introduced into all parts of the world from Europe. The species was first recorded by Kobayashi (1936) from

Korea, without details of collection data and a general description.

Genus *Dendrobaena* Eisen, 1873 밝은뉘시지렁이속 (신칭)

***Dendrobaena rubida* (Savigny, 1826) 밝은뉘시지렁이 (Fig. 7)**

*Enterion rubidum* Savigny, 1826, p. 182.

*Allolobophora tenuis*: Eisen, 1874, p. 44.

*Helodrilus* (*Dendrobaena*) *rubidus*: Michaelsen, 1900, p. 490.

*Bimastus tenuis*: Kobayashi, 1941.

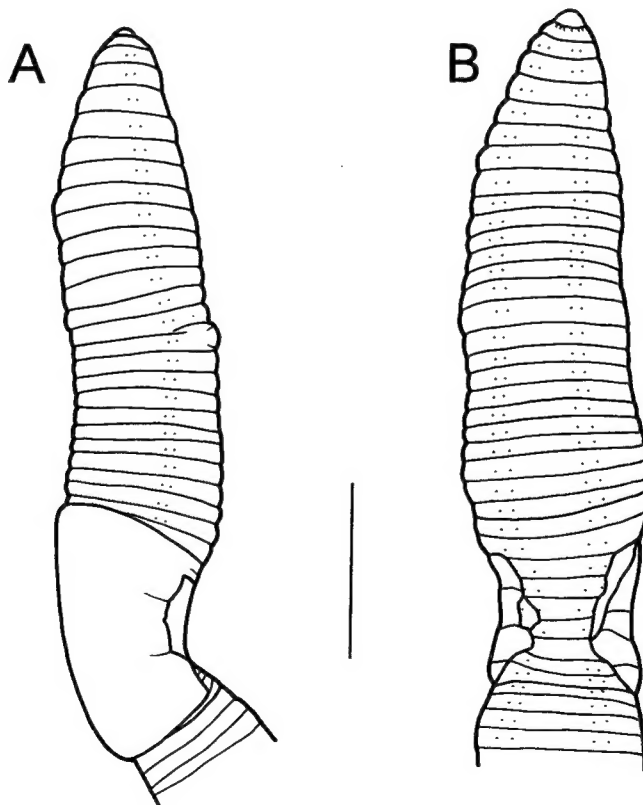
*Dendrobaena rubida*: Gates, 1972a, p. 92; Lee, 1959, p. 359.

*Dendrodrilus rubidus*: Reynolds, 1975, p. 3; Reynolds, 1977, p. 69.

**Material examined.** 7 clitellate specimens, Mt. Naejang, Jeongeup-shi, Jeollabuk-do, 29 June 1996.

**Description.** Length 44 mm, diameter 2.5 mm at segment x, 3.0 mm at clitellum; body cylindrical in cross-section, segments 122. Setae closely paired, 8 per segment around equators, size regular; setal formula  $AA > AB$   $AA > DD$ ,  $AB = CD$ . Prostomium epilobous. Pink or red color formalin preservation. Clitellum saddle shape xxvi-xxxii.

Male pores ventral in xv, between *B* and *C*, protuberant slightly. Tubercula pubertatis absent, if



**Fig. 7.** *Dendrobaena rubida*: A, dorsolateral view; B, ventrolateral view. Scale lines 3.0 mm.

present xxix-xxxi. Genital tumescences none. Female pore lateral to *B* in xiv. First dorsal pore 5/6. Nephropores unrecognizable.

Septa 5/6-6/7 thick, 7/8-13/14 thinner. Gizzard in xvii. Intestine begins in xv, lymph glands absent. Typhlosome small from xxii. Hearts in viii-x. Male sexual system holandric. Seminal vesicles xi-xii, xii large.

**Remarks.** The species is found in a wide range of habitats including gardens, cultivated fields, compost and manure. It is known from Europe and North America (Gates, 1972). *B. tenuis* reported by Kobayashi (1941) was synonymized with this species. In this study *D. rubida* was collected by formalin extraction from forests.

#### Key to the Species of Lumbricidae in Korea

1. Tubercular pubertatis absent ..... 2  
    Tubercular pubertatis present ..... 4
2. Clitellum beginning before segment xxvi ..... 3  
    Clitellum beginning on or behind segment xxvi ..... *D. rubida*
3. Clitellum on segment xxiv, xxv-xxx ..... *B. parva*  
    Clitellum on segment xxiv, xxv-xxxi ..... *B. beddardi*
4. Clitellum beginning before segment xxvii ..... 5  
    Clitellum beginning on or behind segment xxvii ..... 7
5. Tubercular pubertatis beginning before segment xxvii ..... *E. japonica*  
    Tubercular pubertatis beginning on or behind segment xxvii ..... 6
6. Tubercular pubertatis on segments xxviii-xxx ..... *E. fetida*  
    Tubercular pubertatis on segments xxix-xxxi ..... *E. rosea*
7. Tubercular pubertatis on segments xxix-xxxi ..... *E. nordenskjoldi*  
    Tubercular pubertatis on segments xxxi-xxxiii ..... 8
8. Clitellum on segments xxvii-xxxv ..... *A. caliginosa*  
    Clitellum on segments xxvii-xxxiv ..... 9
9. Genital tumescences present on segment xxviii ..... *A. trapezoides*  
    Genital tumescences absent on segment xxviii ..... *A. tuberculata*

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## 한국산 낙시지렁이과(빈모강)의 분류학적 검토

홍 용

(마하리시대학교 생명과학과)

### 요 약

1996년부터 1998년까지 저자가 직접 채집한 표본과 송의 표본(1965-1971)을 동정 분류한 결과 낙시지렁이과의 한국미기록 1종, 흑낙시지렁이 *Aporrectodea tuberculata*을 포함한 7종을 확인하였다. 한국산 낙시지렁이는 3속 10종이 된다.